ORIGINAL ARTICLE

Adverse events experienced while transferring the critically ill patient from the emergency department to the intensive care unit

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Objectives: To determine the incidence and nature of adverse events and delay to patient transfer from emergency department to intensive care unit (ICU) in a metropolitan tertiary hospital.
Method: A 6-month prospective observational study in conjunction with a retrospective chart audit on all emergency department patients admitted to ICU, including those admitted via theatre or after a computed tomography scan.
Results: Equipment problems was the most common adverse event occurring in 9% of patient transfers (n = 290). Hypothermia events occurred in 7% of transfers, cardiovascular events in 6% of patient transfers, delays to transfer >20 min occurred in 38% of the prospectively audited cases, with 14% waiting >1 h. One patient was found to have an incorrect patient identification band during a preoperative check.
Conclusions: This study generally reported lower rates of adverse events than noted in previous studies involving critically ill transfers. The most significant finding was the application of an incorrect patient identification band and has prompted a review of practice. The establishment of benchmark indicators for adverse events and delays in transfer will be useful for future audits.

Critically ill patients are often transferred from the emergency department to the intensive care unit (ICU). These patients may have absent or diminished physiological reserves and any adverse changes in their condition during intrahospital transport have the potential to be lifethreatening.[1]

Adverse events have been reported in up to 70% of intrahospital transports,[2 3] with problems categorised as patient related, equipment related or environmental.[2 4 5] It is unclear from the published research whether physiological changes would have occurred irrespective of the patient being transported or not.[6] Equipment problems and mishaps including battery failure and ventilator disconnection range from 11% to 34%.[5 7–9] Some of these events can be prevented with better planning and communication.[2]

This study sought to determine the incidence and nature of adverse events that occur during the transport process from the emergency department to the ICU in a tertiary referral hospital. Transfer delays between the emergency department and the ICU were also examined.

METHODS

An observational study with prospective data collection and retrospective chart review was conducted over a 6-month period (18 March–31 October 2004) on all emergency department patients admitted to the ICU including patients admitted via the operating room or after a computed tomography scan (ie, ED–ICU, ED–CT–ICU or ED–CT–OR). Approval to undertake the study was granted by the hospital's nursing research review committee and relevant heads of departments.

Patients were identified at both ends of the transfer via emergency department and ICU admissions lists. Staff undertaking the transfer collected data on actual or potential adverse events relating to the transfer process (ie, physiological, environmental or equipment related), including delay in transfer. An adverse event was deemed to have occurred if observations during transfer fell below predetermined thresholds (table 1). In circumstances where haemodynamic parameters were abnormal but explained by the patient's physiology (eg, hypotension in multi-trauma), this was not recorded as an adverse event if pre-transport and post-transport observations remained consistent. Such decisions were verified by author team consensus.

Delay in transfer was defined as a delay of >20 min, in moving from the emergency department to the ICU measured from the time the patient was ready for transfer and the ICU had been informed, to the time the patient departed from the emergency department. This definition of delay was derived by consensus from senior emergency department nursing and medical staff.

Table 1 Number and nature of adverse events occurring during the transfer of critically ill patients from the emergency department to the intensive care unit as proportions of total admissions

Nature of adverse event	n	% of total ICU admissions
Incorrect patient ID label	1	0.3
Hypertension SBP >160 mm Hg or DBP >90 mm Hg	3	1.0
Hypotension SBP <100 mm Hg	4	1.4
Bradycardia <50/min	1	0.3
Tachycardia >100/min	7*	2.0
Arrhythmia	3	1.0
Oxygen desaturation (SpO_2 <95%)	1	0.3
Temperature <35°C (hypothermia)	20	7
Equipment problems	26	8.9
Total patients	290	22.2

DBP, diastolic blood pressure; ICU, intensive care unit; SBP, systolic blood pressure; SpO_2, saturated arterial oxygen.
*In two cases tachycardia was pre-existing on departure from the emergency department, but the rate increased by >10 beats/min during transfer.

Patient health records immediately before transfer from the emergency department (eg, observations, vasopressor/inotrope usage and arterial blood gases if carried out) and on arrival to the ICU were compared to determine whether problems may have been experienced during transfer but omitted from the data sheets. Where temperatures were not recorded in emergency department patient records, and records did not note that action had been taken to warm the patient, investigators assumed that patients were normothermic. Where subsequent temperature recordings on arrival to the ICU were abnormal, it was assumed that hypothermia was related to the effects of the transport process. Patients who were hypothermic on arrival and whose temperature subsequently improved were not recorded to have adverse events even if temperatures remained abnormal, as this reflected an improvement in patient condition.

A 1-month pilot study was conducted to test and refine the data collection tool. Data were entered into an Excel spreadsheet (Microsoft Excel 97) for analysis. Observations before and after transfer were compared. Narrative reports from data collection sheets were used to identify problems experienced during the transfer and explore reasons for transfer delay. Statistical analysis was carried out using SPSS (V.12).

RESULTS

A total of 290 patients were transferred from the emergency department to the ICU during the study period (median age 46 years, range 15–96 years, 66% men). Table 2 shows the patients' presenting conditions by physiological category. Of these patients, 228 (79%) were admitted directly to the ICU and 62 (21%) were admitted via the operating room. Data were collected prospectively on 143 (49%) patient transfers. This group was reviewed for all study outcomes. Of the 143 prospectively enrolled patients, 59 (41%) were transferred to the ICU or operating room after a computed tomography scan. The 147 (51%) patients not included in the prospective phase of the study (because of clinical workload pressures) were examined retrospectively. All patient transfers were included in the chart review. Table 3 compares patient characteristics for both groups.

Adverse events

Sixty six adverse events occurred in 290 patient transfers (table 1). An additional two events were not deemed adverse (ie tachycardia 102/min in a postictal patient with a corresponding temperature of 39℃ and hypertension that was less marked than in the emergency department).

Table 2 Number and nature of critically ill presentations admitted from the emergency department to the intensive care unit during the study period

Presentation type	Prospective enrolments (% of total population)	No in total population (%)
Trauma	47 (16)	89 (30)
ENT	3 (1)	10 (3)
Psychiatric	1 (0.3)	3 (1)
Cardiovascular	9 (3)	29 (10)
GI	6 (2)	20 (7)
Infective/sepsis	5 (1.7)	11 (4)
Neurological	44 (62)	71 (25)
Toxicology	14 (15)	26 (9)
Respiratory	10 (3.5)	20 (7)
Other medical	4 (1.4)	11 (4)
Total	143	290 (100)

ENT, ear, nose and throat; GI, gastrointestinal.

Table 3 Patient characteristics

Characteristic	Prospective (n = 143)	Retrospective (n = 147)
Mechanically ventilated	93 (65%)	89 (60%)
Intra-arterial line in situ	107 (75%)	109 (74%)
Inotropes in ED	93 (65%)	88 (60%)
Non-invasive ventilation	2 (1%)	3 (2%)

ED, emergency department.

Cardiorespiratory events

Cardiorespiratory events occurred in 19 patient transfers. These events were treated with fluid therapy (five occasions of tachycardia), the addition of a vasopressor or inotrope (two occasions of hypotension), change in mode of ventilation (oxygen desaturation) and operative intervention (two occasions of hypotension en route to the operating room). It is unclear whether hypertensive events prompted intervention. Arrhythmia events were all treated successfully and included

1. ventricular fibrillation in a patient enroute to the cardiac catheter laboratory;
2. bradycardia/asystole in a patient with major burns arriving to the operating room for escharotomy; and
3. atrial fibrillation in a patient with gastrointestinal bleeding admitted to the ICU—arrhythmia had not been present in the emergency department.

Hypothermia

Hypothermia-related events occurred most frequently in trauma, toxicological and neurological presentations. In all, 53 (18%) patients experienced a fall in temperature (<36℃) after transfer, with the temperature of 20 patients falling to <35℃. In the hypothermic patients, 8 of 20 (40%) patients were normothermic on presentation and 6 of 20 (30%) were hypothermic (<35℃); they subsequently experienced a further fall in temperature during transfer. The final 6 (30%) patients had no temperature recorded in the emergency department. Patient records did not mention warming treatments. All these patients required active warming on admission to the ICU.

Most patients with hypothermia after transfer (14/20 or 70%) had temperatures between 34℃ and 35℃, but 6 of 20 (30%) patients had lower temperatures, the lowest reaching 32.9℃. Most patients who experienced hypothermia remained within 1℃ of the temperature recorded before departing from the emergency department. Only 5 of 20 patients who experienced hypothermia in transfer had a differential of >1℃ between temperature on departing from the emergency department and that on arrival to the ICU. Patients requiring a computed tomography scan en route to the ICU had a similar rate (47%) of hypothermia to patients not requiring a computed tomography scan (53%; χ^2 df 1; p = 0.30). No patient with hypothermia experienced other complications that could be directly attributed to this event.

Equipment-related events

Equipment-related events were experienced in 26 (9%) patient transfers. Loss of battery charge (n = 13) and equipment malfunction (n = 8) were the most commonly reported events occurring during transfer. Other problems reported included a brief loss of electrocardiogram trace (n = 1), transport ventilator switch accidentally knocked into "off" position (n = 1), leak in oxygen hose to ventilator (n = 1), oxygen gauge indicator failure (n = 1) and loss of

intravenous access while transferring patient during a computed tomography scan (n = 1).

Delays in transfer

Delays in patient transfer from the emergency department to the ICU occurred in 54 of 143 (38%) transfers. One patient experienced a delay time of 6 h. Table 4 provides an overview of delays in transfer.

Table 5 outlines the reasons reported for delay in transfer. On occasions when the ICU was deemed to be ''busy'', emergency department staff were aware that events were occurring to prevent the immediate transfer of patients. Two patients experienced hypotension during the delay period—one was waiting for a computed tomography scan before surgery, the other for an ICU bed. Vasopressor or inotrope treatment was instituted by emergency department staff in both instances.

DISCUSSION

This study evaluated adverse events experienced by patients transferred from the emergency department to the ICU and found that these transfers are generally well managed. Equipment-related problems (9%) and hypothermia (7%) were the most common adverse events. A delay in transfer >1 h occurred in 14% of transfers. Despite the frequency of these events, it is those that occurred infrequently that may actually be the most clinically salient. Cardiorespiratory changes occurred in 6% of transfers. It remains unclear whether these were truly related to the transfer process or whether they were related to the patients' physiological condition and therefore may have occurred regardless of transfer.

The single event involving the incorrect attachment of patient identification band was probably the most noteworthy finding of this study owing to the potential for serious consequences. Although this event was identified by the rigour of the preoperative check and potential harm to the patient circumvented, it could have resulted in disastrous consequences. Had the patient been transferred directly to the ICU, the same degree of rigour in checking identification would not be routinely carried out and may have resulted in a treatment error. Other studies reporting such an error were not found.

The overall adverse event rate of 22% was below the 35–70% reported elsewhere[2 3 6] and may reflect the expertise of escorting staff (senior medical or anaesthetic staff accompanied by a ventilator competent nurse). Nonetheless, some of these events could be avoided by raising staff awareness and refining current approaches in practice.

Hypothermia

Although hypothermia is known to be detrimental to the outcome of patients with trauma,[10] some literature suggests that hypothermia in the neurological patient may be neuroprotective.[11 12] A recent Cochrane review[13] found that mild hypothermia did not reduce mortality in patients with moderate to severe head injury and may actually increase the risk of pneumonia. Only one patient in our sample had hypothermia induced for therapeutic reasons (after cardiac arrest). This patient was excluded from analysis.

Table 4 Time taken to transfer patients from the emergency department to the intensive care unit

Delay time	n	% of transfers
⩽20 min	89	62
21–60 min	34	24
61–120 min	13	9
⩾121 mins	7	5
Total patients	143	100

Table 5 Reason for delay to transfer from the emergency department to the intensive care unit

Delay reason	n	% of transfers
Orderly unavailable for transfer	6	11
Theatre not ready for transfer	4	7
No ICU bed	16	30
No ICU staff	8	15
ICU busy	5	9
No anaesthetist	3	6
CT not ready	5	9
Specialty re-review	4	7
Unknown	3	6
Total no of delayed transfers	54	100

CT, computed tomography; ICU, intensive care unit.

The incidence of hypothermia in this study (7%) is at the lower range reported in the literature (5–12.5%).[10 14 15] The inclusion of patients who had no temperature recorded in the emergency department and had temperatures <35℃ on arrival to the ICU (ie, admitted ED–ICU or ED–CT–ICU) may overestimate the true rate of hypothermia. However, our approach provides a conservative estimate of the magnitude of this event that can be used for quality improvement.

Although this study did not find a statistical difference in the incidence of hypothermia between patients requiring a computed tomography scan and those who did not, it is possible that such a difference may be seen in a larger sample. The proximity of the emergency department to the ICU or operating room may also have influenced the overall hypothermia rate. The ICU and operating room are located adjacent to each other, one level above the emergency department, in a neighbouring building. Access to this building is via a fully enclosed air-conditioned overpass suspended above a road that separates the two buildings. Lift access links the overpass on the emergency department level to the ICU or operating room. The distance from the emergency department to the lift is approximately 250–300 m, and most patients can be transferred in 10–15 min. The computed tomography scanner is adjacent to the emergency department on the transfer route to the ICU or operating room.

Equipment-related events

The rate of equipment-related adverse events reported in this study (9%) is below the 11–34% range widely reported in the literature,[16–19] but could be accurately assessed only in prospective patients. Half of the study incidents related to loss of battery charge. Given that most of the intrahospital transports are of short duration, a closer review of practice in this area is warranted. Loss of battery charge in hospital may be problematic where transport equipment is often used without sufficient periods to recharge. This is often the case in the emergency department owing to the volume and acuity of patients stabilised and transferred each day.

Details on the equipment malfunction reported in this study were limited. This made it difficult to establish a clear explanation for these events or how to prevent them beyond routine staff inservice training.

Delays in transfer

Delay in transfer, when defined as waiting >20 min, was a frequent occurrence (38%). At 1 h 14% of patients still had their transfer delayed. Most delays were related to a lack of ICU beds (30%) or staff (15%). Given the high bed occupancy throughout the hospital (90.7% during the study period, excluding day cases), the discharge of stable patients from

ICU remains a perennial issue. A recent report from the same study site on delays to transfer from ICU reported that 27% of patients deemed ready to leave ICU did not do so within an 8-h period.[20] Narrative comments from the emergency department staff during this study supported this finding. We were unable to determine whether treatments or interventions available only in the ICU were postponed owing to delayed transfer to the ICU. However, anecdotal reports suggest that such delays add to the workload pressure experienced by emergency department staff who may need to reassign resources to cope with delayed transfers.

Staff shortages in the ICU and busy workload accounted for 15% and 9% of transfer delays, respectively, and reflect a substantial proportion of delays (24%) when combined. Workload issues in the ICU are unpredictable and matching of staffing resources to enable a more rapid response to acute patient admissions is necessary to improve efficiency.

A delay in the availability of transport orderlies occurred in 11% of transfers. Possible reasons for this delay may include the occupational health and safety requirement for two orderlies to be available for all transfers of critically ill patients. As the computerised personnel radio system used to communicate orderly activity clearly flags ICU transfers as a priority task, communication should not influence the delays.

The observations of this study are based on a select population of critically ill patients and may not be generalisable to other groups. The use of retrospective data and the reliance on staff responsible for undertaking patient transfer to collect and interpret individual events and processes of care may have reduced the internal validity of results.

CONCLUSIONS

Adverse events were relatively few in this critically ill cohort when compared with other reports. The single major adverse event identified involved a patient with an incorrect patient identification bracelet. Hypothermia and cardiorespiratory events, although frequent, did not result in further serious patient deterioration. Equipment-related events were below the rates reported in the literature,[16–19] with no event causing an adverse outcome in patients. The conduct of this study has allowed the establishment of two key performance indicators, an adverse event rate of 22 of 100 transfers and delay in transfer of 38 of 100, both of which could be used for future benchmarking.

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